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NEURO-EDU-TECHNO (NET) APPROACH IN STUDIES ON EDUCATIONAL THERAPY FOR DEVELOPMENTAL DELAYS: A CASE OF FOCAL CORTICAL DYSPLASIA

Abstract. Przybyła Tomasz, Klichowski Michał, *Neuro-Edu-Techno (NET) Approach in Studies on Educational Therapy for Developmental Delays: A Case of Focal Cortical Dysplasia* [Podejście Neuro-Edu-Techno (NET) w badaniach nad terapią pedagogiczną: Kazus ogniskowej dysplazji korowej]. Studia Edukacyjne nr 52, 2019, Poznań 2019, pp. 97-106. Adam Mickiewicz University Press. ISSN 1233-6688. DOI: 10.14746/se.2019.52.7

Background: Focal cortical dysplasia (FCD) may vary in size and be located in any area of the human brain. In general, FCD causes epilepsy and it is usually associated with mental retardation. Even in case of epilepsy various types of treatment are identified, there is no complete educational therapy for developmental delays caused by FCD. Moreover, there are no works that synthetically discuss the possibilities of supporting such therapy by technology-based solutions. **Method:** Here, we investigate this issue using a systematic literature review. **Results:** Despite the fact that we were dealing with the lack of studies on technology-based educational therapy for students with cognitive problems due to FCD, we point out several potential benefits of this type of assistance. **Discussion and conclusions:** Our study clearly demonstrates that technology may strongly enhance educational therapy for developmental delays caused by focal cortical dysplasia and that there is a need for further neuro-edu-techno (NET) studies on this topic.

Key words: brain malformations, FCD-students, ICT-therapy, developmental retardation, Neuro-MIG

Introduction

Focal cortical dysplasia (FCD), one of the most common malformations of cortical development (MCD),[1] may vary in size and be located in any area

[1] G.M. Mancini, on behalf of Neuro-MIG Network, *Neuro-MIG: A European network on brain malformations*, European Journal of Medical Genetics, 2018, 61, p. 741-743. https://doi.org/10.1016/j.ejmg.2018.07.011.

of the human brain.[2] In general, FCD causes epilepsy[3] and is associated with mental retardation in ~50% of patients.[4] As far as epilepsy is concerned, various types of treatment are well-examined, in particular antiepileptic drugs and surgical management,[5] or numerous non-invasive treatments as such as mammalian target of rapamycin inhibitors, the ketogenic diet or vagus nerve stimulation.[6] Our literature review shows that although there are quite a lot of papers on educational therapy for developmental delays caused by FCD, there are no studies on how to support such therapy technologically.

Database searching

To check how educators can help students with FCD, we analyzed several thousand abstracts from databases such as:

– Academic Search Ultimate,
– AHFS Consumer Medication Information,
– Communication & Mass Media Complete,
– ERIC,
– Health Source – Consumer Edition,
– Health Source: Nursing/Academic Edition,
– Library, Information Science & Technology Abstracts,
– MasterFILE Premier,
– MEDLINE,
– PsycARTICLES,

[2] I.M. Najm, H.B. Sarnat, I. Blumcke, *The international consensus classification of focal cortical dysplasia – a critical update 2018*, Neuropathology and Applied Neurobiology, 2018, 44, p. 18-31. https://doi.org/10.1111/nan.12462; R. Romaniello et al., *Tubulin genes and malformations of cortical development*, European Journal of Medical Genetics, 2018, 61, p. 744-754. https://doi.org/10.1016/j.ejmg.2018.07.012.

[3] J. Kabat, P. Krol, *Focal cortical dysplasia – review*, Polish Journal of Radiology, 2012, 77, p. 35-43; F. Majolo et al., *Notch signaling in human iPS-derived neuronal progenitor lines from focal cortical dysplasia patients*, International Journal of Developmental Neuroscience, 2018, 69, p. 112-118. https://doi.org/10.1016/j.ijdevneu.2018.07.006.

[4] N. Kimura et al., *Risk factors of cognitive impairment in pediatric epilepsy patients with focal cortical dysplasia*, Brain and Development, 2019, 41, p. 77-84. https://doi.org/10.1016/j.braindev.2018.07.014; A. Maulisova et al., *Atypical language representation in children with intractable temporal lobe epilepsy*, Epilepsy & Behavior, 2016, 58, p. 91-96. https://doi.org/10.1016/j.yebeh.2016.03.006; H.H. Chen et al., *Cognitive and epilepsy outcomes after epilepsy surgery caused by focal cortical dysplasia in children: Early intervention maybe better*, Child's Nervous System, 2014, 30, p. 1885-1895. https://doi.org/10.1007/s00381-014-2463-y.

[5] R. Guerrini et al., *Diagnostic methods and treatment options for focal cortical dysplasia*, Epilepsia, 2015, 56, p. 1669-1686. https://doi.org/10.1111/epi.13200.

[6] T.T. Wang, D. Zhou, *Non-invasive treatment options for focal cortical dysplasia*, Experimental and Therapeutic Medicine, 2016, 11, p. 1537-1541. https://doi.org/10.3892/etm.2016.3100.

– PsycINFO,
– Teacher Reference Center.

We used limiters such as published date (2014–2019) and source types (peer-reviewed academic journals), with combination of phrases such as:

– brain malformations,
– cortical dysplasia,
– developmental delays,
– developmental impairment,
– developmental retardation,
– focal cortical dysplasia,
– learning disability,
– malformation of cortical development,
– mental disabilities,
– mental retardation,
– therapy and treatment.

In total, the abstracts came from eighty different journals (for the list of journals, see Table 1).

Table 1

List of analysed journals

No.	Name
1	– Addictive Behaviors
2	– Aging & Mental Health
3	– Annals of Gastroenterology
4	– Aphasiology
5	– Applied Animal Behaviour Science
6	– Archives of Neuropsychiatry
7	– Australian Occupational Therapy Journal
8	– Brain & Development
9	– Brain: A Journal of Neurology
10	– British Journal of Educational Technology
11	– Canadian Journal of Music Therapy
12	– Clinical Genetics
13	– Clinical Neuropharmacology
14	– Clinical Practice in Pediatric Psychology
15	– Continuum: Lifelong Learning in Neurology
16	– Dicle Medical Journal
17	– Disability and Rehabilitation: Assistive Technology

18	– Drug & Alcohol Dependence
19	– Education and Information Technologies
20	– Education and Treatment of Children
21	– eLife
22	– Epilepsia (Series 4)
23	– Epilepsy & Behavior
24	– Epilepsy Research
25	– European Journal of Open, Distance and E-Learning
26	– European Journal of Radiology
27	– Experimental & Therapeutic Medicine
28	– Expert Review of Neurotherapeutics
29	– Focus on Autism and Other Developmental Disabilities
30	– FormaMente
31	– Genetic Counseling: Medical, Psychological, and Ethical Aspects
32	– Genetic Testing & Molecular Biomarkers
33	– Indian Journal of Psychological Medicine
34	– Interactive Learning Environments
35	– International Journal on Disability and Human Development
36	– Intervention in School and Clinic
37	– JAMA Neurology
38	– Journal of Applied Behavior Analysis
39	– Journal of Autism and Developmental Disorders
40	– Journal of Child & Family Studies
41	– Journal of Child Psychology & Psychiatry
42	– Journal of Clinical & Experimental Neuropsychology
43	– Journal of Clinical Child & Adolescent Psychology
44	– Journal of Clinical Neurosurgery
45	– Journal of Developmental & Physical Disabilities
46	– Journal of Education and Practice
47	– Journal of Intellectual Disability Research
48	– Journal of Neurosciences in Rural Practice
49	– Journal of Occupational Therapy, Schools & Early Intervention
50	– Journal of Substance Abuse Treatment
51	– Journal of Technology in Human Services
52	– Journal of the Korean Academy of Child & Adolescent Psychiatry
53	– Journal of the Korean Child Neurology Society

54	– Learning & Individual Differences
55	– Neurobiology of Disease
56	– Neurology
57	– Neurology India
58	– Neuropathology & Applied Neurobiology
59	– Neuropediatrics
60	– Neuropsychiatric Disease and Treatment
61	– Neurosurgery & Neurology of Kazakhstan
62	– Nicotine & Tobacco Research
63	– Pedagogy and Education
64	– Pediatric Neurology
65	– PLoS ONE
66	– Psychiatric Rehabilitation Journal
67	– Psychiatric Services
68	– Research in Developmental Disabilities
69	– Revista Electrónica Educare
70	– Scandinavian Journal of Occupational Therapy
71	– Seizure
72	– Sensors
73	– Speech Communication
74	– Support for Learning
75	– The International Journal of Research and Practice
76	– Themes in Science and Technology Education
77	– Toxicological Sciences
78	– Turkish Online Journal of Educational Technology
79	– Universal Access in the Information Society
80	– Zeitschrift fur Gerontologie und Geriatrie

It turned out that 20% of papers on FCD-therapy were related to some kind of pedagogical assistance (32% of abstracts were associated with surgical management, 30% with medications, 17% with non-invasive treatments and 1% with radiotherapy as FCD-treatment). The forms of educational help mentioned there include: animal-assisted therapy, live music therapy, parent participation in occupational therapy, sensory integration therapy and vibro-acoustic music therapy. These were not complete therapeutic programs but this is not surprising since FCD is a wide spectrum and thus each student requires a very specific (personalized) approach.

The surprise was, however, that there were no works that would discuss the possibilities of supporting educational FCD-therapy by technology-based solutions. And this despite the fact that we added to the search phrases such as:

– educational therapy,
– ICT,
– ICT-therapy,
– media education therapy,
– media therapy,
– teaching strategies,
– technology,
– technology-based therapy.

ICT-therapies, e.g. therapy based on smart toys,[7] tablet applications[8] and many others,[9] are generally very effective and interesting for students with special needs.[10] So, why cannot children with FCD benefit from this potential?

Finally, as Figure 1 shows, our investigation revealed that technology-based educational therapy works well in the context of developmental delays caused by a whole spectrum of disorders (we identified fourteen most popular types). When providing help, teachers or therapists may use various types of technologies (we detected six main groups), from simple tools such as the smartphone, to complex ones such as robots. Students with FCD and their educators do not exist in this techno-debate.

[7] D. Rivera et al., *Smart toys designed for detecting developmental delays*, Sensors, 2016, 16, E1953. https://doi.org/10.3390/s16111953.

[8] A.J. Whitehouse et al., *A randomised controlled trial of an iPad-based application to complement early behavioural intervention in Autism Spectrum Disorder*, Journal of Child Psychology and Psychiatry, 2017, 58, p. 1042-1052. https://doi.org/10.1111/jcpp.12752.

[9] For review, see H. Lidstrom, H. Hemmingsson, *Benefits of the use of ICT in school activities by students with motor, speech, visual, and hearing impairment: A literature review*, Scandinavian Journal of Occupational Therapy, 2014, 21, p. 251-266. https://doi.org/10.3109/11038128.2014.880940; M. Klichowski, *Learning in hybrid spaces as a technology-enhanced outdoor learning: Key terms*, [in:] *Neighbourhood & City – Between digital and analogue perspectives*, eds. M. Menezes, C. Smaniotto Costa, Lisbon 2019, p. 59-68.

[10] M. Petrocelli, *New teaching paradigms in the new machine age revolution*, FormaMente, 2017, 12, p. 9-25; M. Klichowski, T. Przybyła, *Does cyberspace increase young children's numerical performance? A brief overview from the perspective of cognitive neuroscience*, [in:] *Świat małego dziecka. Przestrzeń instytucji, cyberprzestrzeń i inne przestrzenie dzieciństwa*, eds. H. Krauze-Sikorska, M. Klichowski, Poznan 2017, p. 425-444; but cf. M. Klichowski, C. Patrício, *Does the human brain really like ICT tools and being outdoors? A brief overview of the cognitive neuroscience perspective of the CyberParks concept*, [in:] *Enhancing Places through Technology. Proceedings from the ICiTy conference*, eds. A. Zammit, T. Kenna, Lisbon 2017, p. 223-239.

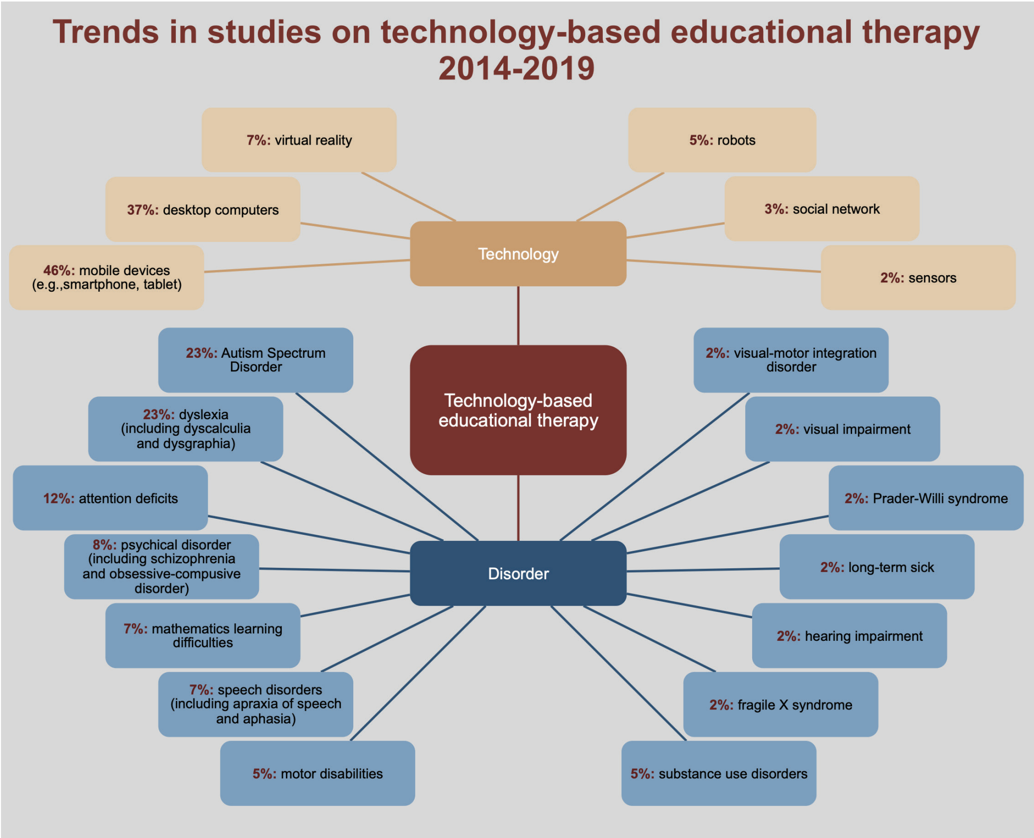

Fig. 1. Trends in studies on technology-based educational therapy in 2014-2019

When analyzing several thousand abstracts from twelve commonly used databases, we found the most popular areas of research in the field of technology-based educational therapy. Although we identified several forms of ICT-therapy for numerous disorders, there were no studies on technology-based educational therapy for developmental delays caused by focal cortical dysplasia

Conclusions

Our analyses clearly demonstrate that technologies are strongly tested, as well as used, in educational therapy for developmental delays. Nevertheless, there are no studies on technology-based educational therapy for students with cognitive problems due to brain malformations such as focal cortical dysplasia. Thus, there is a need for interdisciplinary (i.e. carried out by neuroscientists, educators and technologists) studies on technologically improved educational therapy for developmental delays caused by FCD, as well as MCD. In our opinion, such neuro-edu-techno (NET) approach is a priority here. Our European Cooperation in Science and Technology Action: *European*

Network on Brain Malformations (Neuro-MIG)[11] is a great opportunity for NET-research on educational FCD – and – more broadly – MCD-therapy.[12] However, it is still necessary to share this need in areas other than pedagogy, particularly in neuroscience (due to the fact that the abyss between neurosciences and educational sciences continues to be huge[13]).

Conflict of interest. The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author contributions. The authors contributed equally to this work. Corresponding Author: MK (klich@amu.edu.pl).

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[11] https://www.cost.eu/actions/CA16118.

[12] G.M. Mancini, on behalf of Neuro-MIG Network, Neuro-MIG.

[13] R. Edelenbosch et al., *Brain-based learning and educational neuroscience: Boundary work*, Mind, Brain, and Education, 2015, 9, p. 40-49. https://doi.org/10.1111/mbe.12066; M. Klichowski, *Learning in CyberParks. A theoretical and empirical study*, Poznan 2017.

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